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ON INFANTS' FOOD.*

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One of the subjects which must give us no little thought and trouble at all times, but especially during the summer weather, is how to feed the infant deprived of its maternal supply. Its food must be sufficiently nourishing—*i.e.*, should contain albuminous, fatty, saccharine, and saline ingredients in proper proportions, neither too little nor too much, or nutrition will suffer; it must be easily digestible, else will colic, vomiting or diarrhœa supervene; and it must be practically a sterilized food, free from bacteria or other micro-organisms, else will the infant run the chance of being poisoned by some product of their activity. Many investigators are endeavouring to solve the difficulties which surround the subject. Practically, all unite in regarding cow's milk, or some preparation of it, as the only serviceable substitute for human milk. He would be a rash physician who would dare to order a permanent diet for an infant in which milk did not enter; and every patent food in the market is dependent on it for much of its nutritive material.

The use of cow's milk, however, is attended with some difficulties, which must be clearly appreciated, and overcome, if we would succeed in attaining our three requisite conditions. These difficulties may be briefly stated as follows:

1. Cow's milk contains about double the amount of the

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albuminoids that human milk does, and these albuminoids appear to contain the curd-forming elements in much larger proportion than do the albuminoids of human milk. This large amount of curd is apt to prove a source of indigestion to the infant. The fats and sugars are found in slightly larger amount in human milk than in pure cow's milk, and human milk is always distinctly alkaline, while cow's milk, even when fresh, gives generally a slightly acid reaction.

2. Cow's milk as ordinarily obtained, especially during the hot season, swarms with many varieties of microbes, for which it forms an excellent culture fluid, and during summer weather infant foods prepared with it are generally contaminated with multitudes of these organisms, and with their frequently poisonous products.

3. As cow's milk can be obtained in almost unlimited quantities, and can be supplied to the infant without any regard to regularity, or interval between times of feeding, we have not the same check on the amount, as we have when the infant is dependent on the breast, and with careless or ignorant nurses, we are apt to have complicating the other two difficulties, that of overfeeding.

Each one of these difficulties alone could defeat an attempt to nourish an infant with cow's milk, but operating, as is usually the case, together, it is little wonder that artificial infant feeding often means infant atrophy, and that such a large percentage of such cases, especially in our province, and in our city, perish during the summer months from diarrhœal diseases.

Recent investigation, however, has done a great deal, and, theoretically, all the above difficulties have been solved, yet, clinically, we still find ourselves in trouble.

During the early part of the winter I was confident that we had at last obtained sufficient data on which to construct an ideal infant's food. Our knowledge of the composition of the two milks was sufficiently accurate to enable us to alter the one to make it closely resemble the other in chemical composition. By careful sterilization, with Soxhlet's apparatus, or in an Arnold sterilizer, in bottles holding just sufficient for the one feeding, the milk thus prepared can be administered to the infant

in a practically sterile condition ; while—thanks to the work of Snitken, Holt, and others—we have definite and correct ideas of how much should be given at each time of feeding, and the interval that should elapse between the feedings.

In some of my cases, these means carefully carried out yielded gratifying results, but in others my hopes were disappointed. The infants, though apparently free from digestive troubles, did not thrive, continued to look puny, and only very slowly increased in weight, clearly indicating that my food was faulty.

Since then several communications have from time to time appeared in our medical magazines, where others have related a similar experience ; and corroborating this clinical experience, Dr. Hiesland of Philadelphia and Dr. Leeds of New York have published the results of their individual investigations on the effect that prolonged heat has on the milk. They both speak very similarly of the changes which milk undergoes in the sterilizing process. Their observations may be briefly epitomized as follows :—

I.—The starch liquifying ferment, galactozymase, which exists in normal cow's milk in minute quantities, is destroyed when the heat rises much above 165°F. (75°C.).

II.—A portion of the lactalbumin is coagulated.

III.—The casein, after the action of prolonged heat, is less readily coagulated by rennet, and yields slowly and imperfectly to the action of pepsin and pancreatin.

IV.—The fat globules are injuriously affected by the heat. The fat is freed to some extent, and after standing, small lumps of butter fat are sometimes observed on the surface of the milk, while the portion not freed has a decidedly lessened tendency to coalesce. When sterilized and unsterilized portions of milk were churned, and a note made of the time required to form appreciable amounts of butter, the unsterilized was found to yield a larger amount in considerably less time than the sterilized.

V.—Milk-sugar, by long-continued heating, is completely destroyed ; that it undergoes some change in the process of sterilization is shown by a lessened dextro rotatory power.

It would appear, therefore, that milk, sterilized as we have been doing it, must be regarded as distinctly less readily and less perfectly digestible than raw milk. The destruction of the galactozymase, the coagulation of the lactalbumin, and the alteration of the casein, so that it is more slowly acted on by rennet, all presumably diminish its digestibility by the gastric juice of the infant; while the changes in the fat globules, noted after prolonged sterilization, whatever be their nature, must interfere considerably with their digestion and assimilation.

Yet even with these disadvantages, the testimony of most of the physicians connected with the large foundling hospitals and dispensaries of New York is that it is decidedly to be preferred, as the lesser of two evils, to milk swarming with bacteria. Under its use, the percentage of lives saved has been largely increased, and the number of cases of summer diarrhœa much diminished. But is it not possible to avoid these disadvantages? We all know the benefit that ensues in most cases, when we are able to order the infant to the fresh milk and pure air of the country. Sometimes, for those living in the suburbs, it may be practicable for the family to keep their own cow and attend carefully to its feeding and milking. But for the great majority of the infants in our city, neither of these plans are available; and the question arises, Is all this sterilization necessary to obtain a practically sterile food? Dr. Leeds answers in the negative. He finds that cow's milk rendered feebly alkaline, and heated, as soon as received in the morning, to a temperature of about 155°F. (68°C.) (somewhat short of the degree of heat necessary to coagulate the galactozymase), is rendered practically sterile. His remarks on this point may be quoted:

"It is evident, in the first place, that no milk having an acid reaction, is in a proper condition to be heated, because of the effect of acidity upon coagulation. And inasmuch as cow's milk, as delivered to consumers, has usually developed a notable acidity, the addition of the requisite amount of a suitable alkali is the first point to be considered." By experiments he found that it required, to neutralize this acidity, about 2½ grains of sodium carbonate or 9½ grains of ordinary liquor calcis to the pint of

milk. "On making gelatine-peptone cultures, one drop of the original milk yielded 400 colonies of bacteria after five days' culture at common temperatures, while the same milk rendered very feebly alkaline with lime yielded 250 colonies. Another sample yielded, per drop, 43 colonies after four days and 3,500 colonies after six days. This milk alkalinized by lime gave 14 colonies in the four days and 211 colonies in the six days. After heating for ten minutes in sterilizing flasks at 100°C., both the original and the alkaline milk were practically sterile, developing from 1 to 4 colonies per drop after four days culture. Raw milk, after heating to 68°C. for an hour, proving to be practically sterile (1 to 2 colonies per drop), the experiment was tried at keeping the temperature at 68°C. for six minutes, when the same result was obtained. On cooling and diffusing the cream which the heating had brought to the surface, the appearance and properties of the milk heated to this temperature in no wise noticeably differed from raw milk."

A difficulty arises in securing the proper amount of heat, if we are to have this degree of sterilization carried on in the household. At my suggestion, Mr. Dyer has made a series of experiments with milk contained in glass flasks and heated in an Arnold sterilizer. Having, at the outset, the water in the sterilizer and the milk in the flasks at ordinary temperatures, placing the sterilizer over a brisk Bunsen gas-burner, it took about twelve minutes for the milk in the flask to reach the temperature of 155°. If, now, the gas be turned out, and the cover of the sterilizer be placed slightly ajar, and the milk left in for another five minutes and then removed to a cool place, all the sterilization necessary will have been effected, and none of the deleterious changes will have taken place.

In feeble infants, when the digestive powers are very weak, Dr. Leeds recommends the combination of peptonization with sterilization, the temperature never being allowed to exceed 68°C. Once the temperature rises over 75°C. changes occur which interfere with the digestibility of even the peptonized milk.

In some families even sterilization as directed above, cannot be obtained, either from ignorance or poverty, and in such cases

the use during the summer months of a good brand of condensed milk may perhaps fulfil the conditions. As the condensation of the milk is conducted *in vacuo*, a temperature above 155°F. is, I understand, never reached. Condensed milk has the disadvantage of being very deficient in the amount of the fats it should contain—the cream being to a great extent removed in the process, to secure an absence of rancidity in the prepared article. If condensed milk is used permanently, this element must be replaced by cream, or, perhaps, cod-liver oil, in the cooler months. In preparing this condensed milk for the infant, water that has been boiled, but that has been allowed to cool to about 155°F., should be used.

In the preparation of cow's milk for the infant, the large excess of the albuminoids which it contains must always be borne in mind; bnt in simply diluting it, we must remember we increase the already existing deficiency of the fats and sugars. In a city, and especially during hot weather, cream is always a doubtful quantity and generally contains many bacteria, and for these reasons, I think, should rarely be used in infant feeding. The deficiency of the carbo-hydrates may, however, be often advantageously supplied in children, over two or three months of age, by the addition of a prepared flour of one of the cereals. This method has been long a favorite one with Dr. Jacobi and Dr. Lewis Smith. The cereals used have been principally barley, wheat, and oatmeal, and of these my preference is for the barley. It is the blandest and most nutritious, contains the largest amount of the phosphates, and has neither a constipating nor relaxing action on the intestinal canal.

Mr. Dyer has, at my suggestion, prepared a food of pure barley flour, in which the starch granules have been altered by the action of a heat of 212° maintained for five or six days. At the end of this time the flour has assumed a somewhat yellow colour, a slightly sweeter taste, and a not unpleasant cooked odour. He has had the changes in it carefully examined by Dr. Ruttan, who has found that the starch has been partly converted into dextrose and is thus rendered decidedly more soluble in the juices of the infant stomach.

The addition of such a flour as this to cow's milk, either pure or condensed, does to some extent prevent the formation of large curds, and must supply some of the deficiencies produced when we simply dilute the milk. In the young infants, we should advise its use more as a diluent of the milk, but in infants over six months of age, it may form a fair proportion of the food.

Dr. Ruttan stated that he had been consulted regarding the length of time required to convert barley flour into a more digestible form of food, and also regarding the nature of the change that had occurred. He made a number of experiments, the results of which may be briefly summarized as follows: Barley flour heated to 212°F. for 96 hours was much more easily converted into dextrose by boiling with dilute acids than was the original flour. This change was still more marked when the flour was heated for 144 hours; but if the heating be continued for 24 hours longer, the product became much darker and contained considerable maltose and a caramel-like body, giving it a bitter flavour. Experiments in the artificial digestion of the various products showed that the flour, after 144 hours heating, was very quickly converted into dextrose by an amylolytic ferment; 27 per cent. of the flour so treated was converted into dextrose in fifteen minutes, while but a trace of sugar was formed from the original flour in a parallel experiment. The analysis of the product at the end of 144 hours was made; the starch was nearly all changed into a form of dextrin—part, however, was in the form of amylin and a small part was apparently unchanged. Dr. Ruttan, in the course of his remarks, said he was unable to make out exactly what form of dextrin was produced; it was not ordinary British gum alone, but probably a mixture of soluble starch and some of the intermediate products formed as dextrin passes into maltose and dextrose. Ordinary British gum, such as is used on postage stamps, etc., had never been thought of as an article of food, yet it clearly resembled the chief constituent of flour prepared in this way. This method of preparing flour for infant's food has long been followed in a crude way by

mothers and matrons of infants' asylums. They simply tied the flour in a bag and kept it in boiling water for several days, the result being a similar product to that analysed, but, of course, the conditions necessary to the production of a similar result could not be controlled. One of the great advantages connected with this mode of preparing flour was the coagulation of the albuminoid constituents in a finely granular state.

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